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REVIEW ARTICLE

Sleep bruxism and sleep respiratory disorders in children and adolescents: A systematic review

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Abstract

Objective: Sleep bruxism (SB) is a repetitive rhythmic and nonrhythmic activity. It can be a comorbid condition for other disorders, such as sleep breathing disorders (SBD). However, a clear causal link between these factors is yet to be established. Moreover, this relationship is even more unknown in children. Thus, this systematic review aimed to determine the relationship between SB and SBD in children and teenagers and consolidate the current knowledge about the possible association between both phenomena at the pediatric age.

Materials and Methods: Advanced searches were performed in five electronic databases with the last search updated on February 1, 2023. The methodological quality of the selected studies was analyzed using the quality assessment tool for experimental bruxism studies.

Results: Twenty-nine of 6378 articles were selected for detailed analyses. Most articles found a comorbid relationship between SB and SBD, though no study analyzed a temporary relationship. Due to the heterogeneity of the studies, a meta-analysis could not be performed.

Conclusion: Despite the limitations of this systematic review, it can be concluded that there is an association between SB and SBD in children. However, the level of evidence is low.

KEYWORDS
bruxism, children, obstructive sleep apnea, polysomnography, sleep breathing disorders, sleep bruxism, sleep disorders

1 | INTRODUCTION

Sleep bruxism (SB) was currently defined as masticatory muscle activity during sleep that is characterized as rhythmic (phasic) or nonrhythmic (tonic) (Lobbezoo et al., 2018). The pathophysiology of bruxism is complex and controversial (Lobbezoo & Naeije, 2001), and its etiology is presently considered multifactorial (Lavigne et al., 2007; Manfredini et al., 2017, 2021). There is currently a widespread consensus on the role of the central nervous system and related functional disorders in the etiology of bruxism, which entails a conceptual shift from peripheral (occlusal) to central mediation (d'Incau et al., 2021; Lavigne et al., 2007; Ribeiro-Lages et al., 2020).

Against this backdrop, factors, such as genetics, sleep structure, environment, emotional stress, anxiety, and other psychological disorders, can play a role in the development of bruxism. The dopaminergic system balance, autonomic nervous system, and certain drugs can interact in the etiopathogenesis of bruxism (Lavigne et al., 2007; Schames et al., 2012). A recent literature review revealed evidence regarding medications and substances that can induce SB (de Baat et al., 2021). Selective serotonin reuptake inhibitors can trigger SB, and high-dose phenethylamines may lead to SB in patients with attention-deficit/hyperactivity disorder. Specific medications, such as atomoxetine, duloxetine, ketotifen, methadone, and venlafaxine, can potentially induce or worsen SB. Moderate links between alcohol consumption and SB have also been reported. However, further research is required to draw definitive conclusions.

The prevalence rate of SB in children and young people is higher than that in adults, oscillating between 3% and 40% according to previous studies, and decreasing with age (Drumond et al., 2019; Lamenha Lins et al., 2020; Manfredini et al., 2013; Ng et al., 2002; Sá de Lira et al., 2020; Tsitadze et al., 2021). This major discrepancy in prevalence data is an upshot of methodological questions regarding the nature of the studies (Manfredini et al., 2013). Bruxism in children has been believed to be physiological (Lindqvist, 1973) and the association between malocclusion and bruxism has also been broadly defended (Vanderas & Manetas, 1995); however, these concepts are outdated today (Bulanda et al., 2021; Manfredini et al., 2017).

A definitive diagnosis of SB should be based on questionnaires, clinical examinations, and audiovisually recorded polysomnography (PSG) (Bulanda et al., 2021; Lobbezoo et al., 2018; Manfredini et al., 2017, 2021; Manfredini, Colonna, et al., 2020), which is considered the gold standard (Shiraishi et al., 2021) despite the limitations and drawbacks of its use in children (Parakh et al., 2021; Stražišar, 2021). The Standardized Tool for the Assessment of Bruxism (STAB) is an instrument developed to provide a multidimensional evaluation of bruxism status, comorbid conditions, etiology, and consequences (Manfredini et al., 2023); however, it has not been validated for children and adolescents yet (Manfredini, Ahlberg, et al., 2020).

Sleep-related breathing disorders (SBDs) in children cover a wide spectrum of alterations characterized by greater resistance of the upper respiratory tract, temporary interruption of pulmonary ventilation, and alterations in sleep quality (International Classification of Sleep Disorders, 2014). The conditions clinically related to SBDs range from simple snoring at the low end of the severity scale to more complex manifestations, such as sleep apnea (Giuca et al., 2021; Stark et al., 2018). Upper airway resistance syndrome (UARS) and obstructive alveolar hypoventilation are considered intermediate variants of severity (Dayyat et al., 2007; Guilleminault & Lee, 2004). The prevalence of SBDs in children has shown considerable disparity, ranging from 0.7% to 13%, and is increasing with the increasing trend of childhood obesity (Bixler et al., 2009). This broad prevalence can be partly attributed to the different approaches employed to evaluate the existence of these disorders (Bitners & Arens, 2020). The implications of SBDs in children and young people are fairly widespread and complex (Ehsan & Ishman, 2016; Gozal & Kheirandish-Gozal, 2006; Guilleminault & Stoohs, 1990; Savini et al., 2019). If not treated in time, they can cause substantial morbidity affecting multiple organs and systems, which may not be fully reversible even if treatment for the respiratory condition is established (Al-Shamrani & Alharbi, 2020; Paglia, 2019).

SB can present with SBDs in both adult and pediatric age groups (da Costa Lopes et al., 2020; Jokubauskas & Baltrušaitytė, 2017; Pauletto et al., 2022; Serra-Negra et al., 2017). Although the two are associated with microarousals, no clear causal link has been established to date (Kuang et al., 2022; Shiraishi et al., 2021). Moreover, literature findings on the temporal relationship between SB and obstructive sleep apnea (OSA) are inconclusive, and different scenarios have been described (Kapagiannidou et al., 2021; Kuang et al., 2022; Manfredini et al., 2015; Massahud et al., 2022). The most commonly defended hypothesis is that electromyography (EMG) activity satisfying the features of an SB episode may stop an apneic event as the mandible protrudes, and the permeability of the respiratory tract is restored (Saito et al., 2014). However, SB can also be related to the induction of OSA as a consequence of respiratory tract inflammation resulting from the trigeminal cardiac reflex (Schames et al., 2012). Interindividual differences and the anatomic site of obstruction appear to explain the possible associations between both entities (Manfredini et al., 2015). However, available data on this issue are anecdotal, and the present evidence focuses on adults (De Luca Canto et al., 2014; Jokubauskas & Baltrušaitytė, 2017). The relationship between SB and SBDs in pediatric and adolescent populations is unknown. Moreover, literature regarding this are few, and no systematic analysis on the strength of the data has been done to support or refute the association between SB and SBDs in children and young people to date (Lobbezoo et al., 2020). Given the high prevalence of SB in pediatric and adolescent populations and the serious consequences of SBDs in this population, there is a need to study the potential association between the two phenomena in pediatric patients and clarify the relationship.

Therefore, this systematic review aimed to review the existing literature to determine the relationship between SB and SBDs in children and young people and consolidate the current knowledge about the potential association between the two in the pediatric age group.

2 | MATERIALS AND METHODS

This review was registered in PROSPERO, an international database of prospectively registered systematic reviews (registration number: CRD42021258918).

This review was conducted in accordance with the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses, (Yepes-Nuñez et al., 2021).

The clinical question prepared according to the population, intervention, control, and outcomes (PICO) methodology to guide the development of this review and literature search was: Is there an association between SB and SBDs in children and young people?

The four key components of the PICO question were as follows: population (P) = children and young patients diagnosed with SBD and/or SB; intervention (I) = presence of SB and SBD; comparator (C) = healthy patients; and outcome (O) = presence of an association between bruxism and SBD events (apnea, hypopnea, and snoring). One final component often added to the PICO question was the study design (S), which refers to cross-sectional or cohort studies published in scientific journals.

Advanced searches with detailed and individualized strategies were performed across five databases: National Medicine Library (Medline) database using its online site (PubMed), Cochrane Library, LILACS, Web of Science, and Scopus. References cited in the selected articles were examined to identify relevant publications. This review included language studies published between January 1980 and February 2023. The lower limit of the search was chosen because it represents a significant milestone in the scientific literature and marks the beginning of the availability of scientific publications relevant to the study topic.

An appropriate combination of keywords and Medical Subject Heading terms was initially used in PubMed and adapted for each database.

The studies were selected if they met the following inclusion criteria:

- Studies with children and young people aged between 2 and 18 years of both genders, who had no other important mental or neurological disorders and were not taking any psychoactive medications.
- Studies with at least 10 patients.
- Research type: Descriptive and analytical observational and experimental studies aimed at assessing the relationship between SB and SBDs.
- The SBDs were diagnosed using a hospital or outpatient PSG throughout the night or other appropriate methods based on the International Classification of Sleep Disorders (ICSD-3) proposed by the American Academy of Sleep Medicine (AASM) (International Classification of Sleep Disorders, 2014). The ICSD-3 PSG criteria for diagnosis are either (I) one or more obstructive events (obstructive or mixed apnea or obstructive hypopnea) per hour of sleep or (II) obstructive hypoventilation, as manifested by $PaCO_2$ >50 mmHg for >25% of the sleep time, together with snoring, paradoxical thoracoabdominal movement, or flattening of the nasal airway pressure waveform, implying flow limitation. Alternative tools for diagnosing SDB are also accepted, including nocturnal oximetry studies, respiratory polygraphy (RP) studies, and parent-filled sleep questionnaires (validated and nonvalidated questions about snoring, excessive daytime sleepiness, attention problems, and hyperactive behavior).
- SB was diagnosed based on the clinical and anamnestic criteria of ICSD-3 proposed by the American Association of Sleep Medicine (AASM) (International Classification of Sleep Disorders, 2014). These criteria included, for SB diagnosis, the report of regular or frequent tooth grinding sounds and the presence of one or more of the following clinical signs and/or symptoms consistent with reports of tooth grinding during sleep: abnormal tooth wear consistent with reports of tooth grinding during sleep, transient morning jaw muscle pain or fatigue, and/or temporal headache, and/or jaw locking upon awakening consistent with reports of tooth grinding during sleep. In PSG, SB was defined as three or more rhythmic contractions of the temporalis muscles, as measured with a temporalis muscle EMG, occurring during nonrapid eye movement (NREM) or REM sleep lasting more than 3 s but less than 15 s. Additionally, rhythmic muscle activity was associated with electrocortical arousal or brief waking (<15 s) noted on electroencephalogram. For bruxism to be considered present, the frequency of rhythmic temporalis muscle activity must be at least 75% of the arousal index of each patient. Bruxism was dichotomized into present or absent studies that included only questionnaires (validated or unvalidated) to diagnose SB.

The established exclusion criteria were as follows:

- Studies in adults.
- Studies with fewer than 10 patients.
- Nonresearch articles included reviews, meta-analyses, book chapters, opinion articles, case reports, and laboratory studies.
- Studies in patients without SB and SBD.
- Studies in patients with genetic syndromes or craniofacial anomalies.
- Studies in patients with other mental or neurological disorders.
- Studies on patients undergoing psychoactive or other medication treatments.
- Studies in which the diagnosis method was not clear or not specified.

2.1 | Study selection and data mining

Articles were selected in three stages by two independent reviewers, JF and IOB. The first stage involved examining all article titles to exclude off-topic publications. In the second stage, studies that failed to meet the inclusion criteria according to the data obtained from analyzing the abstracts were excluded. In the final stage, screening was performed by a single reviewer who read the complete text to confirm the eligibility of each study based on the selection criteria.

The data collected from each article included the title, author, year of publication, sample size, inclusion criteria, SB analysis, SBD evaluation method, results, and conclusions.

2.2 | Methodological quality assessment

The methodological quality of the selected studies was analyzed during the complete text reading stage using the Quality Assessment Tool for Experimental Bruxism Studies (Qu-ATEBS) (Dawson et al., 2013). This tool consists of seven items expressed as questions

and is rated on a 5-point Likert scale. The maximum possible score was 70 points; a score between 0 and 50 indicated low quality and a score between 51 and 70 indicated high methodological quality.

2.3 | Confidence in accumulated evidence

A summary of the general strength of the available evidence was performed using the GRADE system (Guyatt et al., 2011). A table was prepared with a summary of the findings using the GRADEpro software. According to this system, evidence quality is initially classified as high or low, depending on where the experimental or observational studies originate, and is subsequently divided into high, moderate, low, and very low according to a series of considerations.

2.4 | Summary of results and statistical analysis

A narrative summary of the relevant findings from the included studies is provided. The data of interest from the included articles were compiled and organized in a table. No meta-analysis was performed given the heterogeneous nature of the studies found.

3 | RESULTS

The initial search identified 6320 articles in the five selected databases and 58 articles through citations. After applying additional filters in the databases and deleting duplicates, 640 potentially relevant articles were retrieved for a more detailed assessment. After evaluating the titles and abstracts, 507 articles were excluded because they were off-topic, and 79 studies were selected for complete text reading. The references cited in these preselected articles were examined; however, no new articles were included. The inclusion and exclusion criteria were applied to the 79 preselected articles to reach a consensus on the articles chosen for systematic evaluation. Among the 79 articles, 50 were excluded because they did not meet the inclusion criteria, and the 29 remaining ones were included and selected for detailed analysis. Figure 1 shows a flow diagram of the process of identification, selection, exclusion, and inclusion of the studies.

3.1 | Quality analysis

The seven-item evidence-based quality assessment tool (Qu-ATEBS) showed that more than half of the studies (Alouda et al., 2017; Arslan et al., 2010; Carra et al., 2011; Castilho et al., 2020; Goyal et al., 2018; Kim et al., 2017; Köstner Uribe et al., 2019; Laganà et al., 2021; Lam et al., 2011; Ng et al., 2002, 2005; Restrepo et al., 2017; Sahin et al., 2009; Segù et al., 2020; Seraj et al., 2010; Serra-Negra et al., 2017; Sheldon, 2010), specifically 17 out of the 29 articles analyzed in this systematic review (41.3%), did not surpass the required score of 50 to be considered good quality. No study achieved a maximum score of 70 as established by this quality assessment tool, with 60 being the highest score attained

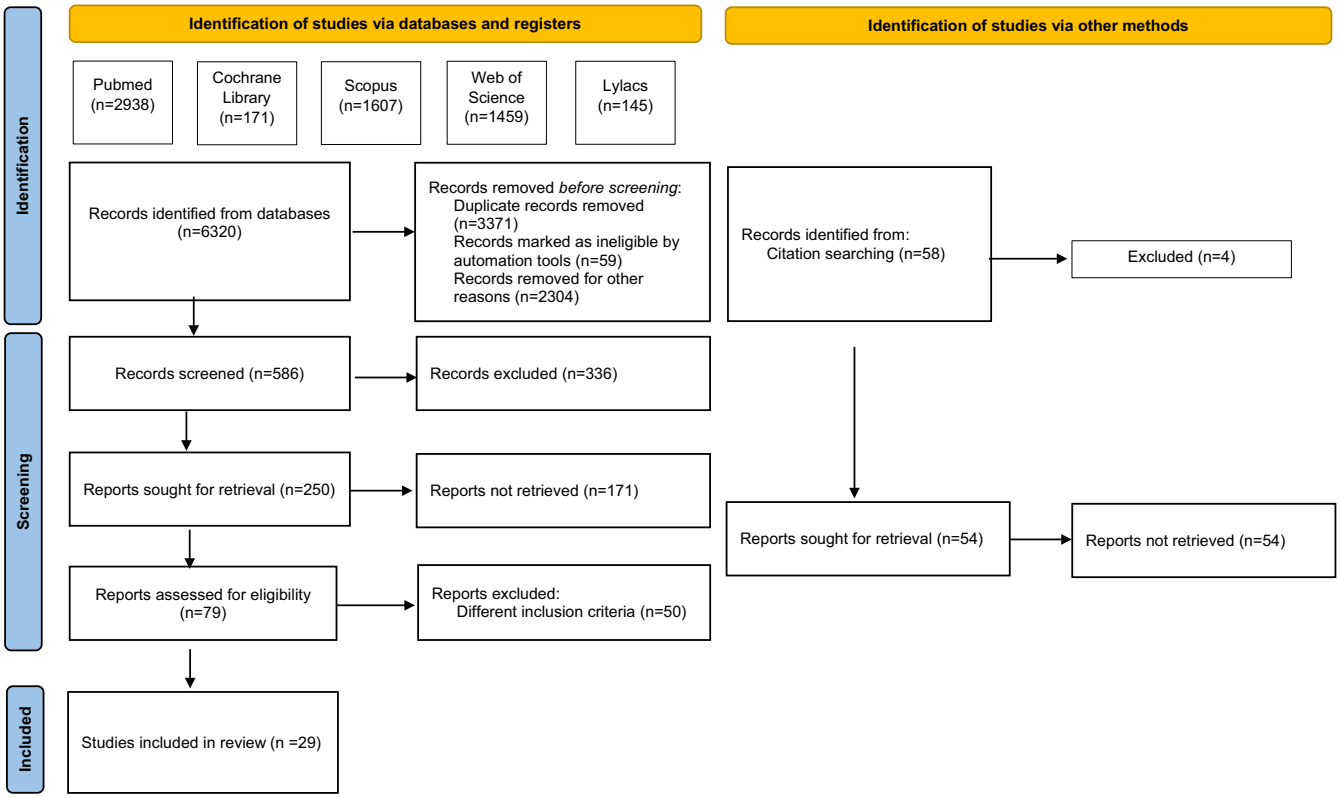

FIGURE 1 PRISMA 2020 flow diagram for the systematic review.

overall, achieved by only one study (Us & Us, 2021). The remaining 11 studies (37.9%) (Alencar et al., 2017; Baidas et al., 2019; Duarte et al., 2019; Eitner et al., 2007; Ferreira et al., 2015; Leal et al., 2021; Oh et al., 2021; Prado et al., 2018; Sá de Lira et al., 2020; Sousa et al., 2018; Tachibana et al., 2016), although falling within the high-quality group, received scores close to 50, which is the threshold between studies considered good and poor quality. Figure 2 shows a graphical representation of the risk of bias of the included studies analyzed using the Qu-ATEBS tool. It presents the scores obtained for each individual study (Figure 2a) as well as an overall representation encompassing all studies (Figure 2b).

The methodological limitations of the included studies were mainly related to the absence of a control group (item 3), experimental bruxism task (item 5), and statistical methods considered inappropriate or insufficiently described (Table 1).

3.2 | GRADE system summary

The quality of evidence identified using GRADEpro was considered very low across all results. Wide confidence intervals, high methodological heterogeneity, and the study design (observational studies) explained the low quality of evidence.

3.3 | Study characteristics and results summary

3.3.1 | Types of studies and age groups analyzed

All articles included in this systematic review were cross-sectional observational studies, except for those by Eitner et al. (2007) and Ng et al. (2002). These two were cross-sectional studies, but with case studies and added controls, which is a variation of this study type, in which cases and controls were obtained from a studied cohort.

Regarding the ages analyzed in the selected studies, more than half (16 of 29; 55%) were children corresponding to primary school ages. The study by Prado et al. (2018) only examined subjects aged 12 years, whereas Eitner et al. (2007) focused exclusively on third-grade primary school children (8–9 years old). Of the 29 studies included in this review, 5 (17%) expanded the age range from primary school to adolescence, and Tachibana et al. (2016) included children starting from 2 years of age in addition to those in primary school. Only the study by Sousa et al. (2018) confined itself to the age range of 11–14 years, which was considered adolescence by the authors. Preschool children, that is, those between 2 and 6 years old, were individually studied in five investigations (17%) (Bezerra et al., 2021; Ferreira et al., 2015; Köstner Uribe et al., 2019; Sá de Lira et al., 2020; Serra-Negra et al., 2017). The study conducted by Kim et al. (2017) was the only one to encompass all age ranges considered in the pediatric scope, that is, from 0 to 18 years. Finally, the remaining studies did not provide details regarding the exact age of the included subjects, only indicating the mean age of the children recruited (Ng et al., 2002). Given the heterogeneity among the included age ranges and limited number of studies involving adolescents and preschoolers, conclusions regarding the effect of age on the relationship between SB and SBDs could not be drawn.

3.3.2 | Association between SB and SBDs

Most included studies established a possible association between SB and SBDs in children and young people. Although 4 (14%) of the 29 articles in this systematic review found no relationship between SB and SBDs (Leal et al., 2021; Lima, 2018; Sá de Lira et al., 2020; Seraj et al., 2010), the rest (86%) confirmed the concomitant presence of both in the studied population.

Among the analyzed respiratory variables, not all articles analyzed OSA and snoring; specifically, 16 (55%) articles addressed snoring, 11 (11%) analyzed SBDs in general, and three were specific to OSA.

Of the selected studies, six focused specifically on analyzing the SB in an isolated fashion with an SBD (21%), of which three studied the relationship between OSA and bruxism (Ferreira et al., 2015; Sheldon, 2010; Tachibana et al., 2016), one analyzed snoring (Ng et al., 2002)and the remaining two referenced SBDs in general (Castilho et al., 2020; Laganà et al., 2021). Other studies (79%) included more variables for analysis, such as possible risk factors for SB or snoring/BSD, other sleep disorders, oral habits, school performance, sleep characteristics, and daytime symptoms.

3.3.3 | Diagnosis of OSA or snoring

Two articles (7%) used objective parameters to diagnose OSA or snoring (Ng et al., 2002; Sheldon, 2010) and found a close relationship between SDB and SB. One study (Sheldon, 2010) reported an apparent association between SB and pediatric OSA. Significant differences were observed between groups with and without SB for the apnea index (AI), apnea–hypopnea index (AHI), and REM AHI. In another study that also employed PSG (Ng et al., 2002), only children reported to have habitual snoring (29/200) were selected for sleep assessment to determine the presence of apnea. However, only 16 of these children underwent a sleep study within 6 months of the initial questionnaire survey (16/29). In the PSG, they found that 11 of the 16 children snored on the night of the study. Two children (2/16, 12.5%) were found to have PSG results indicative of OSA with an AHI greater than one per hour of sleep. For children reported to have SB (17/200), a follow-up was conducted 1 year later to monitor the progression of SB and snoring. Of the 17 children with SB, 16 exhibited habitual snoring ($p < 0.0001$). In 8 of the 13 children that could be contacted improvement in snoring and bruxism was observed (OR = 2.0 [95% CI 0.11–34]) The authors did not compare the presence of SB with the PSG results and the prevalence of OSA.

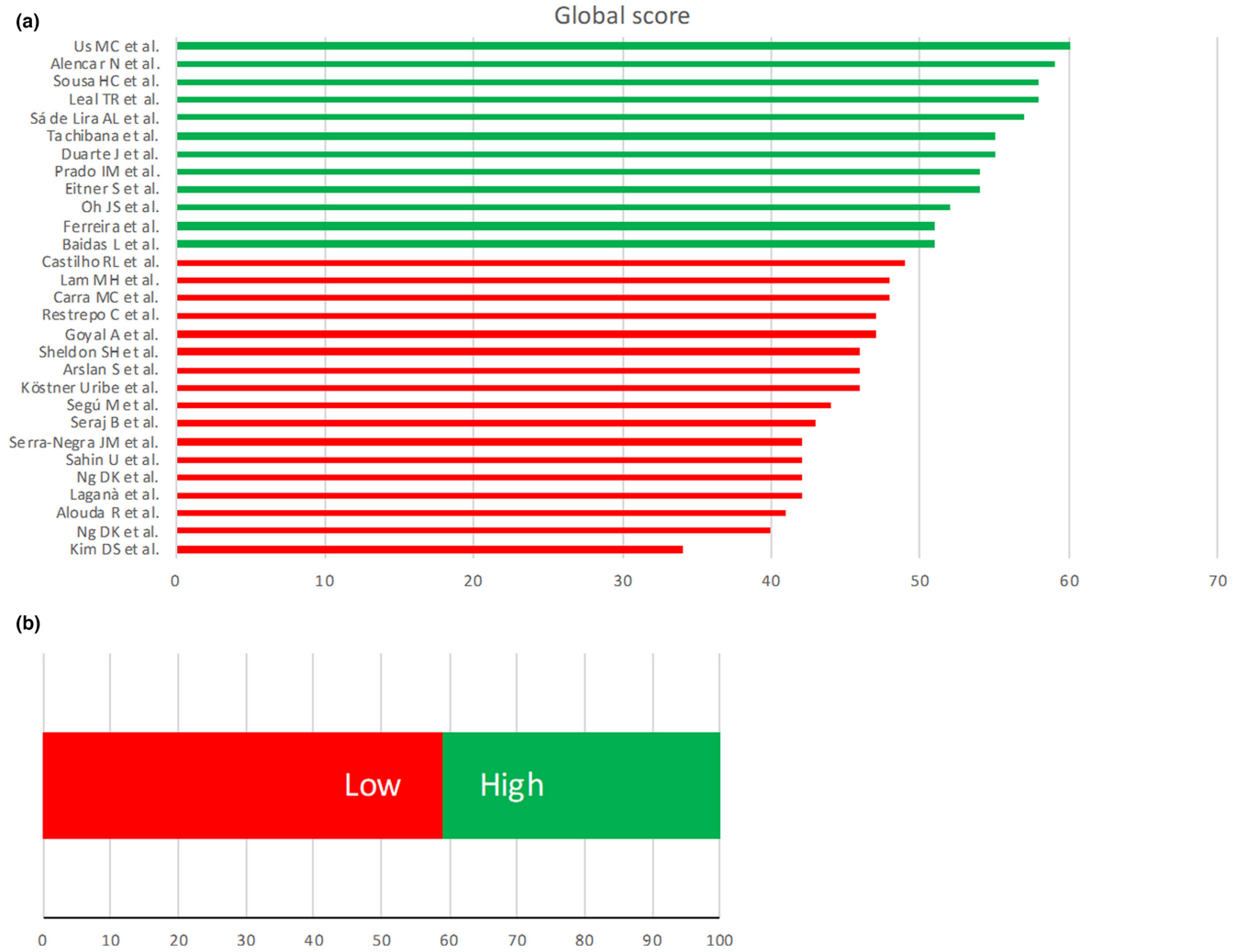

FIGURE 2 Graphical representation of the risk of bias. The color red indicates low quality (score less than 50) and green indicates high methodological quality. (a) Score of each individual study and (b) an overall representation of all the studies.

3.3.4 | Diagnosis of SB

Only Sheldon (2010) employed PSG to diagnose bruxism. The authors' significant findings demonstrated a correlation between objective evidence of rhythmic temporalis muscle activity and pediatric OSA. Among the 29 studies included in this systematic review, 11 (38%) diagnosed SB based on questionnaires and clinical examinations (Alencar et al., 2017; Carra et al., 2011; Castilho et al., 2020; Ferreira et al., 2015; Köstner Uribe et al., 2019; Leal et al., 2021; Oh et al., 2021; Prado et al., 2018; Sá de Lira et al., 2020; Sousa et al., 2018; Us & Us, 2021). Of these 11 studies, three (Carra et al., 2011; Leal et al., 2021; Sá de Lira et al., 2020) concluded that no significant association was found between SB and SDB, whereas the remaining eight found that SDB (snoring and/or OSA) was associated with probable SB among the pediatric population. The remaining articles included in this systematic review (17 of 29; 59%) diagnosed SB solely using questionnaires (Alouda et al., 2017; Arslan et al., 2010; Baidas et al., 2019; Duarte et al., 2020; Eitner et al., 2007; Goyal et al., 2018; Kim et al., 2017; Laganà et al., 2021; Lam et al., 2011; Ng et al., 2002, 2005; Restrepo et al., 2017; Sahin et al., 2009; Segù et al., 2020; Seraj et al., 2010; Serra-Negra et al., 2017; Tachibana et al., 2016). All these studies found that possible SB was associated with SDB.

3.3.5 | Gender analysis

No study included in this systematic review made distinctions in the results considering the gender variable.

3.3.6 | Consideration of other clinical variables

Some studies have considered the presence of other clinical variables, such as respiratory disorders (asthma or rhinitis), mouth breathing, or anatomical abnormalities such as tonsillar hypertrophy, in the selection of subjects with and without SBD. However, these confounding factors were not considered in the final systematic review

TABLE 1 Evaluation of methodology using Qu-ATEBS[a].

Screening questions			Author							
			Alencar et al.	Alouda et al.	Arslan et al.	Baidas et al.	Carra et al.	Castilho et al.	Duarte et al.	Eitner et al.
1	Quality of reporting	Were the study's aims and hypotheses clearly described?	5	4	5	5	5	5	5	5
	Quality of design	Were the aims and hypothesis based on relevant theory?	5	3	5	4	5	3	5	5
2	Quality of reporting	Were the eligibility criteria used to select participants sufficiently described?	5	2	3	4	5	3	5	4
	Quality of design	Were the eligibility criteria appropriate for the objectives of this study?	5	3	3	4	4	3	4	4
3	Quality of reporting	Was it clearly described whether a control group, control condition, or an experimental condition was used?	5	1	2	2	1	1	1	3
	Quality of design	Were the control group, control condition, or experimental condition appropriate for this study, and was a randomization procedure used to randomly allocate subjects to different groups or conditions?	5	3	3	2	3	4	3	3
4	Quality of reporting	Was the study design described in sufficient detail to permit replication?	5	2	2	4	5	3	5	4
	Quality of design	Was the study design appropriately selected for the objectives of this study?	4	2	3	4	4	3	4	3
5	Quality of reporting	Was the experimental bruxism task described in such detail that replication is possible?	4	2	1	1	4	1	4	2
	Quality of design	Was the experimental bruxism task appropriately selected for the objectives of this study?	4	2	1	1	4	1	4	2
6	Quality of reporting	Were statistical methods and data sufficiently described?	4	5	4	5	5	5	5	5
	Quality of design	Were statistical methods and data appropriate for the objectives of this study?	4	5	4	5	5	5	5	5
7	Quality of reporting	Were study conclusions appropriately formulated?	2	4	5	5	3	3	3	5
	Quality of design	Were aims and hypothesis clearly addressed in the conclusion and relevant to the objectives?	2	3	5	5	2	3	2	4
Results			59	41	46	51	48	43	55	54

(Continues)

TABLE 1 (Continued)

Screening questions			Author						
			Ferreira et al.	Goyal et al.	Kim et al.	Köstner-Uribe et al.	Laganà et al.	Lam et al.	Leal et al.
1	Quality of reporting	Were the study's aims and hypotheses clearly described?	5	5	3	4	5	5	5
	Quality of design	Were the aims and hypothesis based on relevant theory?	5	5	3	1	5	5	5
2	Quality of reporting	Were the eligibility criteria used to select participants sufficiently described?	5	5	3	4	4	5	5
	Quality of design	Were the eligibility criteria appropriate for the objectives of this study?	5	5	3	4	4	5	5
3	Quality of reporting	Was it clearly described whether a control group, control condition, or an experimental condition was used?	2	1	1	1	1	1	1
	Quality of design	Were the control group, control condition, or experimental condition appropriate for this study, and was a randomization procedure used to randomly allocate subjects to different groups or conditions?	4	3	2	3	1	2	3
4	Quality of reporting	Was the study design described in sufficient detail to permit replication?	5	4	4	4	3	2	5
	Quality of design	Was the study design appropriately selected for the objectives of this study?	3	4	4	4	3	3	5
5	Quality of reporting	Was the experimental bruxism task described in such detail that replication is possible?	5	1	2	4	3	2	5
	Quality of design	Was the experimental bruxism task appropriately selected for the objectives of this study?	4	1	1	4	3	2	4
6	Quality of reporting	Were statistical methods and data sufficiently described?	3	3	2	2	2	3	4
	Quality of design	Were statistical methods and data appropriate for the objectives of this study?	3	3	2	3	2	3	3
7	Quality of reporting	Were study conclusions appropriately formulated?	1	4	2	4	3	5	4
	Quality of design	Were aims and hypothesis clearly addressed in the conclusion and relevant to the objectives?	1	3	2	4	3	5	4
Results			51	47	34	46	42	48	58

TABLE 1 (Continued)

Screening questions			Author							
			Ng et al.	Ng et al.	Oh et al.	Prado et al.	Restrepo et al.	Sá de Lira et al.	Sahin et al.	Segú et al.
1	Quality of reporting	Were the study's aims and hypotheses clearly described?	5	3	5	5	5	5	5	5
	Quality of design	Were the aims and hypothesis based on relevant theory?	4	3	5	5	5	5	3	5
2	Quality of reporting	Were the eligibility criteria used to select participants sufficiently described?	4	2	3	5	2	5	3	3
	Quality of design	Were the eligibility criteria appropriate for the objectives of this study?	4	3	3	5	3	5	3	3
3	Quality of reporting	Was it clearly described whether a control group, control condition, or an experimental condition was used?	NA	1	1	NA	1	3	NA	NA
	Quality of design	Were the control group, control condition, or experimental condition appropriate for this study, and was a randomization procedure used to randomly allocate subjects to different groups or conditions?	NA	2	1	NA	3	4	NA	NA
4	Quality of reporting	Was the study design described in sufficient detail to permit replication?	3	4	4	5	4	4	5	3
	Quality of design	Was the study design appropriately selected for the objectives of this study?	3	4	3	5	4	5	5	3
5	Quality of reporting	Was the experimental bruxism task described in such detail that replication is possible?	3	2	5	5	2	4	1	2
	Quality of design	Was the experimental bruxism task appropriately selected for the objectives of this study?	3	2	5	5	2	4	1	2
6	Quality of reporting	Were statistical methods and data sufficiently described?	4	3	4	5	4	3	5	4
	Quality of design	Were statistical methods and data appropriate for the objectives of this study?	3	3	4	5	4	3	5	4
7	Quality of reporting	Were study conclusions appropriately formulated?	3	4	5	2	4	4	3	5
	Quality of design	Were aims and hypothesis clearly addressed in the conclusion and relevant to the objectives?	3	4	4	2	4	3	3	5
Results			42	40	52	54	47	57	42	44

(Continues)

TABLE 1 (Continued)

Screening questions			Author					
			Seraj et al.	Serra-Negra et al.	Sheldon et al.	Sousa et al.	Tachibana et al.	Us et al.
1	Quality of reporting	Were the study's aims and hypotheses clearly described?	5	3	4	5	5	5
	Quality of design	Were the aims and hypothesis based on relevant theory?	5	4	4	3	4	5
2	Quality of reporting	Were the eligibility criteria used to select participants sufficiently described?	4	1	4	5	5	5
	Quality of design	Were the eligibility criteria appropriate for the objectives of this study?	4	1	4	5	5	5
3	Quality of reporting	Was it clearly described whether a control group, control condition, or an experimental condition was used?	2	2	NA	2	2	2
	Quality of design	Were the control group, control condition, or experimental condition appropriate for this study, and was a randomization procedure used to randomly allocate subjects to different groups or conditions?	2	2	NA	2	2	2
4	Quality of reporting	Was the study design described in sufficient detail to permit replication?	2	4	4	4	4	5
	Quality of design	Was the study design appropriately selected for the objectives of this study?	2	4	4	4	4	5
5	Quality of reporting	Was the experimental bruxism task described in such detail that replication is possible?	1	3	5	4	2	5
	Quality of design	Was the experimental bruxism task appropriately selected for the objectives of this study?	1	3	5	4	2	5
6	Quality of reporting	Were statistical methods and data sufficiently described?	2	4	2	5	5	5
	Quality of design	Were statistical methods and data appropriate for the objectives of this study?	3	3	2	5	5	5
7	Quality of reporting	Were study conclusions appropriately formulated?	5	5	4	5	5	3
	Quality of design	Were aims and hypothesis clearly addressed in the conclusion and relevant to the objectives?	5	3	4	5	5	3
Results			43	42	46	58	55	60

Abbreviation: NA, Not applicable.

[a]Two review team members scored each item on a scale from "strongly disagree" to "strongly agree." The items were phrased as questions and rated on a 5-point Likert scale. The maximum attainable score was 70 points; a score between 0 and 50 was considered "low quality" and between 51 and 70 "high quality."

analysis, which could have potentially led to changes in the obtained results.

Table 2 summarizes the data obtained and extracted from each study.

4 | DISCUSSION

Although the results of this systematic review support the association between SB and SDB in children, the available evidence is low, and the results are mostly based on subjective assessments of SB. Therefore, the evidence level must be increased by conducting well-designed clinical studies. Therefore, the methodological and design flaws reported in this review must be assessed accurately.

Two main types of studies have considered the assessment of SB and SBDs. The first type assessed SB in an isolated fashion with SBD (Castilho et al., 2020; Ferreira et al., 2015; Laganà et al., 2021; Ng et al., 2002; Sheldon, 2010; Tachibana et al., 2016), while the second type included more variables for analysis, such as possible risk factors for SB or snoring/SBD and other sleep disorders, oral habits, school performance, sleep characteristics, and daytime symptoms. Various diagnostic tools have been used to assess SB and SBDs. Although PSG is considered the gold standard for diagnosing both conditions, it has only been used in two studies (Ng et al., 2002; Sheldon, 2010). This needs to be addressed by the scientific community to standardize the diagnostic assessment of both entities in children and adolescents, to unify the criteria and avoid invasive diagnostic tools (Gerdung et al., 2022; Lavigne et al., 2021). The extension of the STAB tool at the pediatric level could be a step forward in this regard (Manfredini et al., 2023). The definition of the time windows in which events are considered to be associated requires standardization. It would be interesting and helpful to draw more concise conclusions regarding the possibility of data sharing as an act of open science. This paves the way for meta-analyses based on individual patient data. This type of meta-analysis is more reliable (Stewart & Tierney, 2002). Conventional meta-analysis depends on the manner in which the aggregate data are described. This systematic review is a practical example of this dependency, preventing the statistical matching of data to reach more conclusive findings on the association between SB and SBDs.

The included studies varied according to the children's age. While some studies examined only children with primary teeth (Köstner Uribe et al., 2019), others studied only adolescents (Prado et al., 2018). Regarding the prevalence of SB, a common trend across the literature is an inverse relationship between prevalence and age; in other words, the prevalence of bruxism declines with age in the pediatric population (Manfredini et al., 2013). With respect to the prevalence of pediatric OSA, two peaks have been distinguished: the first occurs in children aged 2–8 years, related to the presence of adenoid hypertrophy and/or enlarged tonsils, while the second peak surges during adolescence in relation to an increase in weight (Chang & Chae, 2010; Lo Bue et al., 2020). Therefore, the pathophysiology of OSA in pediatric patients can vary by age group. The staging of OSA into two types in line with physiopathology and pediatric age made it difficult to compare OSA across different age groups without a more precise diagnosis, since it was not possible to know whether different OSA phenotypes were being compared, in which the relationship with SB could be different.

Therefore, the entire study population must be considered. While most of the studies included in this review were based on school-aged children, others focused on patients who present at hospitals or dental clinics, and one study was performed in a sleep disorder clinic (Sheldon, 2010). In fact, this study used PSG as a diagnostic tool, given its accessibility, considering the setting in which the study was implemented. The results of different studies can, therefore, question their comparability, since it is likely that hospital patients present with comorbidities that could influence the results, while the prevalence of SB and OSA found in the general population could be lower.

Therefore, the findings of this systematic review should be analyzed carefully because discrepancies in the results lead to very low quality, as shown in the GRADE findings summary.

The lack of systematic reviews in the literature addressing the relationship between SB and SBDs in children and young people impedes the comparison of the findings of this systematic review. By analyzing the literature focusing on several disorders or sleep behaviors in children, a single systematic review was previously published (Guo et al., 2017). These results matched those highlighted herein, as they included snoring as a risk factor for bruxism in children. A further systematic review of children with general risk factors for bruxism coincided with our results that sleep disorders were strongly associated with SB (Abuduhaer et al., 2007).

This systematic review revealed the frequent comorbidities in children with SB and SBDs. However, most selected studies were cross-sectional observations. The drawback of this type of study is that it does not enable the establishment of a causal relationship between the analyzed conditions. Four possible scenarios explain the relationship between SB and SBD (da Costa Lopes et al., 2020; Manfredini et al., 2015). However, most of these scenarios have been studied in adults (Jokubauskas & Baltrušaitytė, 2017) given the scarcity of studies on SB and OSA in children that use PSG to compare the temporal relationships between these phenomena. This absence of PSG, in the studies included in this systematic review, to clarify the temporal relationship between the two phenomena makes it difficult to establish whether this association is physiological and protective in children or simply involves the coexistence of two independent events (Lobbezoo et al., 2018; Manfredini et al., 2015, 2021; Tan et al., 2019). Thus, the association or causality between SB and SBDs remains unclear. Although we were unable to determine whether OSA is a trigger for SB or vice versa, it is important to consider them as frequent comorbidities (Pauletto et al., 2022). The relative prevalence of a specific sequence of events can vary at an individual level. Therefore, it is possible that there are different types of bruxism and OSA phenotypes that could explain the

TABLE 2 Characteristics of the included studies.

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Alencar et al. (2017)	Lifestyle and oral facial disorders associated with sleep bruxism in children with sleep bruxism in a Japanese population	2017	$n=66$	No	Children aged 3–7 years old. Complete primary or mixed dentition. No medical or mental disorders.	AASM criteria: Questionnaire (yes/no answer about audible teeth grinding, no medical or mental disorders, and no other SD) and clinical examination.	Interviews with parents/ caregivers (sleep history).	34SB;32C MLR association snoring and SB ($p<0.20$). Backward stepwise LR: snoring associated SB (OR = 0.14; $p=0.013$; coefficient of determination $R^2=0.289$).	Snoring is associated with nocturnal bruxism in children.
Alouda et al. (2017)	Mother's work status on children's bruxism in a subset of Saudi population	2017	$n=561$	No	Children aged 4–10 years old.	Survey with a closed ended questions about child's sleeping pattern (teeth grinding questionnaire and CSBS).	Survey with a closed ended questions about child's sleeping pattern (CSBS).	A bruxing child was more than twice as likely to snore as a nonbruxing child (OR = 2.129 [1.395–3.250], $p<0.05$).	A child that snores is more than twice as likely to be a nocturnal bruxer than a child that does not have these habits.
Arslan et al. (2010)	Habitual snoring in primary school children: prevalence, risk factors, and school performance	2010	$n=1952$	Yes	Children aged 6–16 years old.	Nonvalidated questionnaire (yes/ no answer).	Nonvalidated questionnaire (yes/no answer apnea and 4-point scale snoring: never, occasionally, often, always).	Prevalence: habitual snoring = 4.9%, occasional snorers = 28.2%, and never snorers = 66.9%. SB: Never snorer 5.1% versus habitual snorer 10.4%. OR (95% CI) 2.21 (1.09–4.49).	Night-time symptoms like bruxism as well as daytime symptoms were highly correlated with habitual snoring.
Baidas et al. (2019)	Prevalence of sleep-disordered breathing and associations with orofacial symptoms among Saudi primary school children	2019	$n=1350$	Yes	Children aged 6–12 years old. No syndromes and compromised craniofacial anomalies.	Nonvalidated questionnaire (yes/ no answer about teeth grinding during sleep).	Questionnaire (PSQ)	Tooth grinding (sleep) more common in high-risk SBD children ($p<0.001$). Logistic regression analyses ($p<0.05$): Children SB higher risk of SDB. Tooth grinding (sleep): Univariate analysis: OR (95% CI) = 1.958 (1.185–3.234); $p=0.009$. Multivariate analysis: OR (95% CI) = 1.998 (1.214–3.289) $p=0.007$.	The study showed an association between SDB symptoms and tooth grinding.

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Carra et al. (2011)	Prevalence and risk factors of sleep bruxism and wake-time tooth clenching in a 7- to 17-year-old population	2011	$n=604$	No	Children aged 7–17 years old. Seeking orthodontic treatment for craniofacial anomalies and/or aesthetic reasons.	Questionnaire (French version of PSQ: yes/no answer) and clinical examination.	Questionnaire (French version of PSQ and PSQI) and clinical examination.	(1) Control subjects (CTL), (2) SB subjects (SB), and (3) wake-time TC subjects (TC). Both SB and TC more sleep problems than CTL. SB higher prevalence of loud breathing during sleep compared CTL group ($p=0.009$), but no significant association between SB and snoring or sleep apnea complaint reports. SBD did not differ between groups. Snoring = CTL 19.3%; SB 29.3%; TC 26.2%. $p=0.1$ (1 vs. 2); 0.3 (1 vs. 3); 0.8 (2 vs. 3). Sleep apnea = CTL 0.9%; SB 0.0%; TC 4.8%. $p=1$ (1 vs. 2); 0.1 (1 vs. 3); 0.2 (2 vs. 3).	In conclusion, this study supports, at least in a pediatric population seeking orthodontic treatment, that SB and wake-time bruxism are two different conditions with little overlap. Whether this is a result of age and developmental maturation factors is unknown at this time. Further research and clinical trials are required to better understand and define the relationship between oral parafunctions and TMDs, SDB, and behavioral signs and symptoms.
Castilho et al. (2020)	The interface between dentistry and respiratory sleep disorders in children	2019	$n=152$	Yes	Children aged 6–11 years old	Nonvalidated questionnaire (yes/no answer) and clinical examination.	Questionnaire (OSA-18 quality of life: 18 items scored on a ordinal scale of 7 points [no time – every time]) and clinical examination.	Risk of OSA: low 59% (OSA1), moderate 19% (OSA2), and high 9% (OSA3). Bruxism: 38% OSA1, 42% OSA2, and 67% OSA3. $p=0.0144$.	Bruxism was a significant finding in children at higher risk of OSA. Significant evidence of respiratory problems, including sleep disorders, associated with oral alterations, has been observed suggesting a considerable relation between mouth breathing in children and changes in stomatognathic system.

(Continues)

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Duarte et al. (2019)	Association of possible sleep bruxism with daytime oral habits and sleep behavior in schoolchildren	2019	$n=544$	Yes	Children aged 8–10 years old. Male or female gender. Presence at school day of data collection. No use of orthodontic appliance. No syndrome (such as Down) or cognitive impairment.	Questionnaire (Brazilian version of SBQ: 29 questions with five scored response options [1 "never" to 5 "always"])	Questionnaire (Brazilian version of SBQ: 29 questions with five scored response options [1 "never" to 5 "always"]).	Prevalence of SB was 21% and significantly higher in children reports of snoring. Univariate Poisson regression ($p<0.001$; PR = 2.407; 95% CI: 1.752–3.307). Multiple Poisson regression model: PSB significantly associated with "snoring" ($p<0.001$; PR = 1.931; 95% CI: 1.408–2.648).	Possible sleep bruxism in schoolchildren is associated with possible awake bruxism, snoring, sleep fragmentation, and daytime sleepiness.
Eitner et al. (2007)	Sleep problems and daytime somnolence in a German population-based sample of snoring school-aged children	2007	$n=1144$ 1 year later, snore habitually ($n=114$) versus snore never or occasionally ($n=114$)	Yes	Children from third grade.	Questionnaire (German version of SDSC: 26 items yes/no answer).	Questionnaire (German version of SDBQ: Responses rated on a 4-point scale [never–always]).	First phase do not analyze relation SB-Snoring. Follow-up results: 40/82 long-term habitual snorers (LTHS) and 42/82 ex-habitual snorers. All SDSC subscales showed higher values in the LTHS, which was statistically significant for SWTD. Ex-habitual snoring group SWTD values were only slightly higher ($p<0.001$). Comparing LTHS and control, adjusted for gender and age, logistic regression showed significantly increased ORs for an abnormal score in SWTD (OR [95% CI] = 4.4 [1.4–14.2]). Comparing ex-habitual snorers and controls, significantly increased ORs were found also for an abnormal SWTD score (OR [95% CI] = 12.0 [3.8–37.3]).	Habitual snoring in children may be associated with several sleep problems as well as with daytime tiredness and sleepiness. Long-term habitual snorers has increased risk for SWTD (rhythmic movements, hypnic jerks, sleeptalking, bruxism). They may be of particular importance, because they may bridge the snoring-induced sleep impairment and the daytime tiredness/sleepiness.

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Ferreira et al. (2015)	Sleep bruxism associated with obstructive sleep apnea syndrome in children	2015	$n=496$	Yes	Children of preschool age (3–6 years old). No neurological compromise, children medicated with psychotropic drugs and esophageal reflux.	Nonvalidated questionnaire (yes/no answer) and clinical examination.	Nonvalidated questionnaire (yes/no answer) and clinical examination.	25.61% SB and 4.83% OSA. 2.82% presented both conditions. A statistical association SB and OSA ($p=0.001$; chi-square test): 11.03% of SB also OSA and 97.18% of subjects without SB not present OSA. No statistical association was found among children's gender and age and the presence of SB or OSA.	Within the limits of this study, SB was associated with OSA.
Goyal et al. (2018)	Association of pediatric obstructive sleep apnea with poor academic performance: A school-based study from India	2018	$n=1346$	Yes	Children aged 5–10 years old.	Nonvalidated questionnaire about sleeping habits (yes/no answer).	Questionnaire (Hindi, version of pediatrics SRBD scale: 22 symptom items with three options answer [yes/no/do not know]).	Students with positive SBD had higher chances of having bruxism (29% vs. 15.4%; $p<0.0001$, adjusted OR: 1.7; 95% CI: 1.1–2.6), respectively. Logistic regression analysis SB – SBD >33.0%: Univariate (unadjusted) OR (95% CI)=2.2 (1.5–3.4), $p<0.001$. Multivariate (adjusted) OR (95% CI)=1.7 (1.1–2.6), $p=0.0271$.	There is no reference to the association between OSA and SB in the conclusion, but in the results they found an association between both of them.
Kim et al. (2017)	Sleep problems in children and adolescents at pediatric clinics	2017	$n=901$	No	Patients who visited a pediatric clinic (0–18 years old)	Questionnaire (PSQ).	Questionnaire (PSQ).	SDB 15.1%. Snoring 31.6%. Habitual snoring (>3 day/week) 16.9%. Bruxism 21.1%. Significant difference in the rate of SB between the three groups of snoring. SB: no snoring=18%; snoring=29%; habitual snoring=26% ($p=0.001$). SDB: no snoring=18%; snoring=29%; habitual snoring=26% ($p=0.001$) Logistic regression analysis did not show a high incidence of SB in snoring patients.	Children with snoring have an increased risk of sleepwalking, SDB night terror, and bruxism.

(Continues)

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Köstner Uribe et al. (2019)	Sleep disorders associated with sleep bruxism in children between 3 and 6 years old attended at the Dental Clinic of the University Mayor of Santiago, Chile	2019	$n=100$	No	Children aged 3–6 years old. Temporary or mixed dentition in the first phase. No interceptive orthodontic treatment (previous or current). No medications that alter muscle activity (serotonergic antidepressants, neuroleptics, antidopaminergic, and/or amphetamines for treatment of attention deficit).	AASM criteria: Questionnaire (yes/no answer about audible teeth grinding, morning pain and mandibular lock) and clinical examination.	Questionnaire SDSC	Prevalence of SB 47%. LR Test association between SB and SD: SBD significant association with BS ($p=0.046$), but very close to not being considered a significant association.	There is a relationship between sleep bruxism and some sleep disorders, such as parasomnias, SBD, sleep hyperhidrosis, and not restful sleep.
Laganà et al. (2021)	Sleep Bruxism and SDB in Albanian Growing Subjects: A Cross-Sectional Study	2021	$n=310$	No	Children aged 6–12 years old. Not undergone orthodontic treatment before or during. No severe systemic diseases. No secondary bruxism induced by systemic diseases and/or drugs. No medicines that can affect the nervous and muscular systems. No severe mental illness, or significant mental disorders.	Nonvalidated questionnaire (yes/no answer).	Nonvalidated questionnaire (yes/no answer).	18.7% snore overnight. 36% of SB children snore ($p=0.00$). Two symptoms of OSA: night sweating and nocturia. 41.6% SB children sweating at night ($p=0.02$), while in 15.5%, an increase of nocturia was registered ($p=0.04$). OSAS' risk factors (tonsillitis and enlarged adenoids): No positive correlation with SB ($p>0.05$).	Heredity, night sweating, nocturia, oral breathing, and snoring seem to have a significant correlation with bruxism.

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Lam et al. (2011)	A community study of sleep bruxism in Hong Kong children: Association with comorbid sleep disorders and neurobehavioral consequences	2011	$n = 6389$	Yes	Children of grades 1–6 from primary schools (4–11 years old)	Hong Kong version CSHQ.	Hong Kong version CSHQ.	Prevalence of SB 5.9%. By using Bonferroni correction ($p < 0.002$), after adjustments for gender and age effect: SB was associated with sleep-related breathing problems: Snoring OR = 3.55, 95% CI (2.67–4.71). Adjusted OR = 3.29 95% CI (2.46–4.39). Logistic regression of factors related to SB: SBD were found to be strongly associated with SB OR (95% CI): Snoring = 2.26 (1.51–3.38); night sweating = 2.37 (1.58–3.55) and dry mouth 1.67 (1.03–2.07).	SB was found to be associated with a variety of medical conditions, neuropsychiatric sequelae, and comorbid sleep conditions, especially sleep-related breathing disorders and sleep talking.
Leal et al. (2021)	Influence of the practice of sports, sleep disorders, and habits on probable bruxism in children with mixed dentition.	2021	$n = 739$	Yes	Children aged 8–10 years old. No physical or mental disabilities. Not undergone orthodontic treatment. Not SB treatment. Live with a parent/guardian.	Questionnaire (Brazilian version of SDSC) and clinical examination.	Questionnaire (Brazilian version of SDSC).	The prevalence of probable SB was 9.1%. In the final model, SBD (OR = 1.04; 95% CI: 0.93–1.16, $p = 0.43$) were not associated with probable SB.	The occurrence of probable sleep bruxism was influenced by some sleep disturbance but not with SBD.
Ng et al. (2005)	Prevalence of sleep problems in Hong Kong primary school children	2005	$n = 3047$	Yes	Children aged 5–16 years old.	Questionnaire (Hong Kong version CSHQ).	TuCASA questionnaire.	Prevalence of snoring (10.9%, 95% CI = 10–12), witnessed sleep apnea (1.5%; 95% CI = 1–2), and sleep teeth grinding (20.5%; 95% CI = 19–22). Sleep teeth grinding is a significant risk factor for snoring (0.442; $p > 0.001$; OR 1.56; 95% CI = 1.25–1.94), but not for witnessed sleep apnea.	Significant risk factors for habitual snoring included sleep teeth grinding.

(Continues)

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Ng et al. (2002)	Habitual snoring and sleep bruxism in a pediatric outpatient population in Hong Kong	2002	$n=200$	No	Children attended the outpatient department of a hospital.	Nonvalidated questionnaire (yes/no answer).	Nonvalidated questionnaire (yes/no answer) and PSG.	29/200 = 14.5% (95% CI = 10–20) habitual snoring. 17/200 = 8.5% (95% CI = 5–13) SB. SB closely related to snoring 16/17 ($p<0.0001$). 13 SB 1 year later changes in symptoms of snoring and SB. 8/13 improved SB and snoring, 16/29 snoring in questionnaire accepted PSG: 11/16 snoring; 2/16 OSA.	Habitual snoring and sleep bruxism was found to be closely related. Further studies into this relationship are needed.
Oh et al. (2021)	Determinants of probable sleep bruxism in a pediatric mixed dentition population: a multivariate analysis of mouth versus nasal breathing, tongue mobility, and tonsil size	2020	$n=96$	No	Children aged 6–12 years old. No respiratory disease, known comorbidities, prescribed medications for chronic disease, premature birth, craniofacial defect, prior orthodontic therapy, prior tonsillectomy, prior oral or maxillofacial surgery.	Questionnaire SDSC and clinical examination.	Questionnaire SDSC and clinical examination.	23/96 probable SB SD evaluated among children positive for SB (SD = SB: 45.1 ± 13.0 vs. no SB: 34.8 ± 5.5; $p<0.0001$). Snoring and difficulty breathing and/or gasping for air during sleep increased odds of SB: Snoring (OR = 6.1; 95% CI = 2.0–18.4; $p<0.0001$) and difficulty breathing and/or gasping for air during sleep (OR = 8.7; 95% CI = 2.5–30.0; $p<0.0001$). Increased tonsil size, functional ankyloglossia, and inability to breathe through the nose greater odds of probable SB. Increased tonsil size: Pearson's chi-square ($n=96$, df = 3) = 20.0, $p<0.0001$. Functional ankyloglossia: Pearson's chi-square ($n=96$, df = 3) = 31.4, $p<0.0001$. Inability to breathe through the nose: Pearson's chi-square ($n=96$, df = 1) = 16.2, $p<0.0001$. Multivariate analysis suggests that restricted tongue mobility was an independent risk factor for SB when controlling for nasal breathing and tonsil size. The incidence of PSB among individuals with all three exam findings was 10/11 (90.9%), $p<0.0001$.	Parental reports of snoring during sleep and difficulty breathing and/or gasping for air during sleep were all associated with SB. In addition, clinical findings of tonsil hypertrophy, nasal obstruction, and restricted tongue mobility were found to have a synergistic association with the incidence of probable sleep bruxism.

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Prado et al. (2018)	Study of associated factors with probable sleep bruxism among adolescents	2018	$n=231$	Yes	Children aged 12 years old.	Questionnaire (nonvalidated questionnaire about audible tooth grinding: yes/no answer) and clinical examination.	Questionnaire (nonvalidated questionnaire about snoring: yes/no answer).	Prevalence of probable SB was 16.9%. Adolescents who snored during sleep had more chance of being in the group with probable SB. Logistic regressions: univariate analysis (OR = 2.947; 95% CI = 1.455–5.971; $p=0.003$) and multivariate analysis (OR = 3.148; 95% CI = 1.478–6.704; $p=0.003$).	Snoring was associated with probable SB among adolescents.
Restrepo et al. (2017)	Sleep behaviors in children with different frequencies of parental-reported sleep bruxism	2017	$n=1500$	Yes	Children aged 6–13 years old.	Questionnaire: Spanish version of CSHQ.	Questionnaire: Spanish version of CSHQ.	Prevalence of proxy-reported SB 26.1%. Total sample: scores of SBD, increased with the frequency of SB, one-way ANOVA test for between-group differences was significant ($p<0.05$). SBD = no SB 3.46 (1.0); sometimes SB 3.88 (1.1); usually SB 4.34 (1.4) ($F=60.88$ $p<0.001$). Snores loudly = no SB 1.27 (0.6); sometimes SB 1.44 (0.6); usually SB 1.86 (0.9) ($F=69.2$, $p<0.001$). Stops breathing = no SB 1.19 (0.4); sometimes SB 1.36 (0.5); usually SB 1.48 (0.5) ($F=45.7$, $p=0.02$). In the different socioeconomic layers, SBD in the low, medium, and high socioeconomic layers increased significantly with the frequency of SB. Differences statistically significant for all between-group comparisons (Bonferroni post hoc <0.05). Low layer: SBD = no SB 3.3 (1.0); sometimes SB 3.88 (1.1); usually SB 5.0 (1.4) ($F=39.2$, $p<0.001$). Medium layer: SBD = no SB 3.4 (1.0); sometimes SB 3.8 (1.1); usually SB 4.2 (1.4) ($F=20.0$, $p<0.001$). High layer: SBD = no SB 3.5 (1.2); sometimes SB 3.7 (1.0); usually SB 4.2 (1.4) ($F=12.3$, $p<0.001$).	SBD increased with the frequency of proxy-reported SB, independently on the socioeconomic layers.

(Continues)

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Sá de Lira et al. (2020)	Prevalence of sleep bruxism in children in primary dentition	2020	$n=365$	Yes	Children aged 2–6 years old. Primary dentition. No motor disturbances, psychiatric disorders, or systematic diseases. No orthodontic treatment.	AASM criteria: Questionnaire (nonvalidated questionnaire about audible tooth grinding: yes/no answer) and clinical examination.	Questionnaire (nonvalidated questionnaire about snoring: yes/no answer).	SB rate was 28.3% ($n=105$). G1 = SB and GC = control. Distribution of harmful habits and symptoms associated with sleep bruxism (chi-square test/p value). Snoring at night: G1: =18/105; GC = 42/265; χ^2/p value = 0.24/0.88. There was no association between SB and snoring.	There was not an association between sleep bruxism and the habit of snoring at night.
Sahin et al. (2009)	Habitual snoring in primary school children: prevalence and association with sleep-related disorders and school performance	2009	$n=1605$	Yes	Children aged 7–13 years old.	A 55-item, multiple-choice validated questionnaire.	A 55-item, multiple-choice validated questionnaire.	41/1164 HS (3.5%); 412/1164 occasional snorers (35.4%) and 711/1164 nonsnorers (61.1%). Prevalence of snoring 38.9%. Witnessed sleep apnea = 42 children (3.4%). Tooth grinding = 21.6%: HS had a twice greater probability of TG than nonsnorers. TG: nonsnorers 17.3%; occasional 28.7%; HS 34.1%; $p<0.001$, OR 1.93 (95% CI: 0.99–3.74).	Children with HS were more likely to have sleep-related daytime and nighttime symptoms like teeth grinding.
Segù et al. (2020)	Correlation between parental-reported tooth grinding and sleep disorders: investigation in a cohort of 741 consecutive children	2020	$n=741$	No	Children aged 8–12 years old in orthodontic treatment.	Questionnaire SDSC.	Questionnaire SDSC.	70.1% of children were not reported to have sleep-time tooth grinding, while in 14.4%, it was reported "occasionally," in 7.3%, "often," and in 4.1% either "very often" or "always." Spearman test reported a significant correlation between parental-reported tooth grinding and several sleep disorders: sleep breathing difficulties ($r=0.163$), sleep apnea ($r=0.092$), and snoring ($r=0.157$). Mean values and SD with the corresponding p value: Sleep breathing difficulties (1.41 SD = 0.847; $p=0.002$); sleep apnea (1.1 SD = 0.500; $p=0.001$); snoring (1.71 SD = 0.980; $p=0.002$). In general, correlation strength of significant pairs was low.	Nocturnal breathing symptoms (sleep breathing difficulties, sleep apnea, snoring, and nocturnal sweating) showed a correlation with parental-reported tooth grinding.

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Seraj et al. (2010)	The prevalence of bruxism and correlated factors in children referred to dental schools of Tehran, based on parents' report	2010	$n=600$	No	Children aged 4–12 years old referred to dental schools. Informed consent signed by parents.	Nonvalidated questionnaire (yes/no answer to SB).	Nonvalidated questionnaire (yes/no answer related to SD).	26.2% SB parasomnias 53.2% of children, snoring being the least stated (4.5%). SB in 35.1% of children with parasomnias versus 16% of subjects without any sleep disorders (significant difference). There was not a correlation between snoring and SB: Snoring in 37% of BS children versus 63% of no SB children ($p=0.2$).	Based on parents' report, the prevalence of bruxism in 4–12 years old children was 26.2%. There was a significant relation between bruxism and parasomnias specially drooling and sleep walking, but not significant relation between bruxism and snoring.
Serra-Negra et al. (2017)	Association between possible sleep bruxism and sleep characteristics in children	2017	$n=111$	No	Children aged 4–15 years old.	Criteria from ICSD: questionnaire (nonvalidated questionnaire: yes/no answers about audible nocturnal grinding of teeth).	Nonvalidated questionnaire with closed questions about snoring (yes/no answer).	Most children with SB snore (72.4% – $p<0.001$). Multinomial logistic regression model: children who snored during sleep were more likely to have SB (OR = 8.25, 95% CI = 2.56–26.54).	There is a strong association between SB and snoring these two habits, requiring more inquiry. Muscle pains, snoring, and mouth breathing were important signals associated with possible sleep bruxism among children.
Sheldon (2010)	Obstructive sleep apnea and bruxism in children	2010	$n=119$	No	Children aged 3–16 years old. Symptoms of snoring half the time heard in other rooms.	PSG.	PSG.	SB 70/119 (group 1). No SB 49/119 (group 0). AI significantly different = group 0 averaged 0.8 ± 1.6 and group 1 averaged 4.0 ± 10.8 (two-tailed $p=0.02$). Significant differences were also seen between groups for the AHI ($z=-3.60$; $p<0.001$) and the REM AHI ($z=-2.96$; $p=0.003$).	SB seems to be associated with pediatric OSA. Sleep-related rhythmic temporalis muscle activity associated with arousal is significantly associated with indices of respiratory disturbance, particular the AI, AHI, and REM AHI, as measured using standard pediatric polysomnographic techniques.

(Continues)

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Sousa et al. (2018)	Prevalência e fatores associados ao bruxismo do sono em adolescentes de Teresina, Piauí	2018	$n = 594$	Yes	Adolescents aged 11–14 years old present in the school on the day of data collection.	Questionnaire (nonvalidated yes/no answer associated with SB) and clinical examination of dental wear.	Questionnaire (nonvalidated, yes/no answer about presence of snoring).	Prevalence of SB 22.2%. Distribution of independent variables: A positive association in the bivariate analysis between SB and snoring ($p < 0.05$). The PRs obtained in the multivariate analysis: snoring (PR = 1.39; 95% CI 1.02–1.89) was associated with > prevalence of SB in final model.	The presence of snoring was one of the factors associated with a higher prevalence of SB, suggesting such a sleep-related respiratory disorder as a predictor of the condition.
Tachibana et al. (2016)	Associations of sleep bruxism with age, sleep apnea, and daytime problematic behaviors in children	2016	$n = 6023$	No	Children aged 2–12 years old.	Questionnaire: JSQ-P and JSQ-E.	Questionnaire: JSQ-P and JSQ-E.	21.0% reported tooth grinding during sleep. Chi-square test showed significant association between SB and snoring ($p < 0.001$). SB had significant correlations with five items for OSA: "moves a lot during sleep" (OR = 1.78; $p < 0.0001$), "sleeps with mouth open" (OR = 2.00; $p < 0.001$), "sleeps with head arched back" (OR = 1.99; $p < 0.0001$), "snores loudly" (OR = 2.59; $p < 0.0001$), "stops breathing" (OR = 2.37; $p < 0.0001$), and "snores and gasps" (OR = 2.14; $p < 0.0001$). Multivariate logistic regression analysis "moves a lot during sleep" (OR = 1.47; $p < 0.0001$), "sleeps with mouth open" (OR = 1.56; $p < 0.0001$), and "snores loudly" (OR = 1.80; $p < 0.0001$) remained significantly higher in children with SB compared with children without SB.	Parent-reported SB was found to be correlated with clinical signs related to sleep-disordered breathing. The comorbidity of OSA may contribute to the relationship between daytime problematic behavior and SB. Loud snoring and mouth opening during sleep were independently correlated with tooth grinding during sleep, while witnessed respiratory pause was not.

TABLE 2 (Continued)

Authors	Title	Year	Sample size	Sample size calculation	Inclusion criteria	Diagnosis of SB	SBD assessment	Results	Conclusions
Us et al. (Us & Us, 2021)	Evaluation of the relationship between sleep bruxism and sleeping habits in school-aged children	2021	$n=618$	No	Children aged 6–12 years old. No medical history of neurological or psychiatric disease, and a parent signing.	ICSD criteria: Questionnaire (nonvalidated yes/no answer about teeth grinding during sleep and morning jaw muscle pain or fatigue and/or temporal headache and/or jaw locking upon awakening) and clinical examination (signs of tooth wear and muscle pain).	CSHQ.	Frequency of sleep disorders in the entire group 61.4% (n: 307). Frequency of SB in children with sleep disorders 55% (mean score, SD: 53.8 ± 11.03); incidence of SB statistically higher in children with sleep disorders (OR: 5.513, 95% CI: 3.110–9.770, $p<0.001$). Sleep-disordered breathing significantly high in the SB group (mean score, SD: 4.53 ± 2.00, $p<0.001$): stops breathing (21.8%, $p=0.03$), snores loudly (48.7%, $p<0.001$), snorts and gasps (28.1%, $p=0.005$). In the adjusted multiple logistic regression model analysis, the presence of sleep-disordered breathing significantly increased the incidence of SB (OR: 1.350, 95% CI: 1.185–1.538, $p<0.001$).	SB is a prevalent disorder that might be associated with some sleep disorders. Further studies investigating the relationship between SB and SD are needed to confirm these findings.

Abbreviations: AASM, American Academy of Sleep Medicine; AHI, apnea–hypopnea index; AI, apnea index; C, control; CSHQ, Children's Sleep Habits Questionnaire; HS, habitual snorers; ICSD, International Classification of Sleep Disorders; JSQ-E, Japanese Sleep Questionnaire for elementary school students; JSQ-P, Japanese Sleep Questionnaire for Preschoolers; MLR, multiple logistic regression; OR, odds ratio; OSA, obstructive sleep apnea syndrome; PSQ, Pediatric Sleep Questionnaire; PSQI, Pittsburg Sleep Quality Index; SB, sleep bruxism; SBQ, Sleep Behavior Questionnaire; SD, sleep disorders; SDB, sleep-disordered breathing; SDBQ, sleep-disordered breathing questionnaire; SDSC, Sleep Disturbance Scale for Children; SRBD, sleep-related breathing disorder scale; TG, tooth grinding; TuCASA, Tucson Children's Assessment of Sleep Apnea.

differences found between studies and the different temporal relationships between the two events (Smardz et al., 2020; Wieczorek et al., 2020).

In this systematic review, children with pathologies such as Down's syndrome, cerebral palsy, or asthma were excluded Nevertheless, other authors have studied the relationship between OSA and SB (Luconi et al., 2021; Tae et al., 2020). Besides, only studies that included snoring or apnea among their variables were analyzed. In this regard, the study by Laganà et al. (2021) stands out, in which, in addition to snoring, other symptoms frequently found in patients with OSA such as enuresis, dry mouth, oral breathing, and night sweats were evaluated. Several studies have been found in the literature that analyze the relationship between these symptoms and SB (Drumond et al., 2019; Lamenha Lins et al., 2020), but if they have not included the snoring and apnea variables, these studies were not included. This is explained by the fact that the symptoms of OSA are diverse, and some of these symptoms are not always related to the pathology.

This systematic review had several limitations. The most important limitation was the level of clinical evidence provided by the articles, which was very low across all results. Subanalyses of age and gender could not be performed. Another limitation is that several diagnoses have were included, SBDs as snoring, apnea, and potential risk factors for SBDs. However, these disorders differ in terms of severity and comorbidities and should, therefore, be analyzed independently. Extensive experimental and clinical longitudinal studies are required to understand the underlying pathophysiological mechanisms and to definitively establish the causality between SB and SBDs in children and young people.

Future studies should include diagnostic tools, such as video-monitored PSG, and involve larger samples of prediagnosed mixed SBD and SB populations. Another point for mention for future research on SBDs and SB in children is to distinguish between age groups and consider participant gender and body mass index to determine whether these variables could influence the end results.

Studies should include a control group of healthy patients, preferably paired by age, gender, body mass index, and patients with central sleep hypopnea/apnea and UARS.

Changes in sympathetic nervous system activity and their relationship with arousal should also be investigated to determine the intermediate factors involved in apnea events and bruxism and to clarify the temporal relationship between them.

5 | CONCLUSIONS

Within the limitations of this systematic review, SB and sleep-breathing disorders are sleep disorders that frequently appear in pediatric and adolescent populations, where a close relationship could be observed. However, there is no scientific evidence on the pathophysiological association between these two conditions in children and young adults.

Given the heterogeneous nature and low methodological quality of the studies, more well-designed studies with control groups are required to assess the temporal relationship between SB and sleep-breathing disorders.

5.1 | Clinical relevance of this systematic review

Concerning the clinical relevance of the findings from this systematic review, given the high prevalence of SB in the pediatric and adolescent population and the serious consequences of SBDs on the pediatric age group, the confirmation of a causal relationship between the two phenomena would enable an early diagnosis of the latter pathology. SB could, therefore, become a predictor of SBDs by making it possible to suspect the existence of this important pathology in the pediatric age group when there are signs and symptoms of SB. In this aspect, the dentist becomes important in the management of a patient with SBD, establishing the first suspected diagnosis. Conversely, some studies have shown that OSA treatment can improve clinical outcomes in patients with SB.

AUTHOR CONTRIBUTIONS

Idoya Orradre-Burusco: Investigation; formal analysis; writing – original draft; methodology; resources. **Julio Fonseca:** Visualization; supervision; validation; writing – review and editing. **Mohammad Hamdan Alkhraisat:** Visualization; supervision; validation. **Júnia Serra-Negra:** Visualization; supervision. **Asier Eguia:** Visualization; supervision. **Aintzane Torre:** Visualization; supervision. **Eduardo anitua:** Visualization; supervision.

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CONFLICT OF INTEREST STATEMENT

Anitua E is the Scientific Director of BTI Biotechnology Institute (Vitoria, Spain), a dental implant company that investigates in the fields of oral implantology, PRGF-Endoret technology, and obstructive sleep apnea. Alkhraisat MH is a researcher at BTI Biotechnology Institute. The rest of the authors do not have any conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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